MECO INSTRUMENTS PVT. LTD., (Navi Mumbai) one of the largest manufacturers of Electrical / Electronic Testing and Measuring Instruments in India with a large range of products since last 44 years

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THEORY OF HARMONICS:

A Harmonic can be defined as "A Sinusoidal component of a periodic wave or quantity having a frequency that is an integral multiple of the fundamental frequency" Harmonics can be thought of therefore as voltages and/or currents present on an electrical system at some multiple of the fundamental frequency. A Harmonic is a component of Frequency of a harmonic motion that is an integral multiple of the fundamental frequency. Fundamental frequency is 50Hz in our country. Integral multiple means multiplying the fundamental frequency by a whole number such as 2,3,4 etc. Typical harmonics for a 50Hz system are the 5^{th} (250 Hz) the 7^{th} (350 Hz) and the 11^{th} (550 Hz.) Modern electronic power generally uses current rectifier for control and regulation. But theses power supplies present non-linear loads to the AC Power lines. Thereby, besides the increased reactive power, harmonic currents become particularly high and theses currents in flowing through the power line impedance cause harmonic voltages to occur on the power line. Not only that, but also Transformers that demand high magnetizing currents, electric arc furnaces, gas discharge lamps etc in their own ways have undesirable effects on the power lines. Contamination of the power lines with harmonics result in unfavorable reactions at other consumers and installations. e.g. Reading errors in electronic instruments, false instruction to unmanned remote operated equipments, excessive line loss, Thermal loading of motors, possible destruction of phase shift capacitors and transformers malfunction of computers and other sensitive equipments.

Just as high blood pressure can create stress and serious problems in the human body, high levels of harmonic distortion can create stress and resultant problem for the utility's distribution system, the plant's distribution system, as well as all of the equipment that is serviced by that distribution system. The result may be the plant engineer's worst fear the shutting down of important plant equipment ranging from a single machine to an entire line or process.

Pollution of Power Systems due to injection of Harmonics by a variety of non-linear loads operated mostly in industries has been an insurmountable problem in modern power system. The main contributors of Harmonics are the power converters used in Adjustable Speed Drives in Rolling mills, Paper mills, Printing Works, Electrolytic plant & Electrostatic precipitators, Traction Systems, SVC, HVDC Converter, Welding machines, Arc Furnaces etc. These disturbing loads form a considerable part of the present day loads and are expected to grow at a faster rate due to need of better energy management and rapid industrial growth.

SOURCES OR CAUSES OF HARMONICS

A growing power quality concern is harmonics distortion that is caused by the non-linearity of customer loads. A nonlinear load is a circuit element where voltage is not proportional to its current. Until.

- Electronic power converters e.g. adjustable speed drives, power supplies are by far the larges contributors to harmonic distortion in today's plant environment. An electronic power converter changes electrical energy from one form to another, typically by chopping up the power waveform and reassembling it in its own unique manner. This change is accomplished by using solid-state devices.
- Rapid use of energy conservation devices in both domestic sectors and industrial sectors such as electronics chokes for tube lights; electronics energy controllers for the motors and electronic fan regulators etc. also inject harmonics substantially.
- Large use of the shunt capacitors to improve power factor and stability has significant influence on harmonic level. Related to the supply system converters and traction are the major causes of generation of harmonics.
- More use of solid state power converters for industrial furnaces for mini steel and non-ferrous metal plants, use of thryistors for locomotives, extensive use of single phase electronic loads in domestic sectors are causes of harmonic generation.

IMPACTS OF HARMONICS ON VARIOUS EQUIPMENT

Sr. No.	Equipments	Effects of Harmonics
1	Circuit Breakers	False Tripping
2	P.F. Correction Capacitors	Blowing of fuses, Overheating, Bursting, Series/parallel resonance, Over Voltages, High Circulating Current
3	Telecommunication lines	Interferences
4	Induction-Type meters	Read high
5	Average reading meters	Read Low
6	Fluorescent lamps	High peak value due to Harmonics reduces life
7	Protective relays	Unpredictable behavior
8	Fan Motors	Electronic regulators produce a humming sound
9	Neutral of 3 – phase 4 wire system	Zero-sequence currents add Size to be increased Neutral displacement
10	Machines	Increased losses Lower efficiency Counter-rotating mmf
11	Resistive parts	Added loss
12	Magnetic circuits	Added loss
13	Computers	Interference
14	Auto-voltage regulator	Malfunctioning
15	Auto PA System	Interface
16	ZnO arresters	Increased loss

CONTROLS & REMEDIES FOR HARMONICS

- Limit harmonic current injection from nonlinear loads Transformer connections can be employed to reduce harmonics in three phase system using parallel delta-delta and star delta transformers to yield net 12-pulse operation or delta connected transformers to block triple harmonics.
- The Harmonic distortion in adjustable speed drives can be controlled will within IEEE 519-1992 limits by drive design modification, switching from 6 pulses to higher pulses converters, connection of series reactor.
- Modify system frequency response to avoided adverse interaction with harmonic currents. This can be done by feeder sectionalizing adding or removing capacitor banks adding shunt filters or adding reactors to detune the system away from harmful resonances.
- Applying Harmonic like Filter harmonic current at the loads or on the system with shunt filters or try to block the harmonic currents produced by the loads. There are number of devices to this. Their selection is largely dependant on the nature of the problems encountered. Solution can be as simple as an in-line reactor (i.e. a choke) as in the PWM based adjustable speed drive applications or complex as designed active filter.
- In the Reactor (i.e. Choke) as in the PWM based adjustable speed drive applications or complex as designed active filter.
- Monitoring problem manifested in V, I, Hz. Data acquisition is the primary step for both the situations. The requirement is the data on the current and voltage distortion both as it exists.
- For Quality performance of various Power system devices it is necessary to understand the problems deeply and requires further remedial measures for improvement and better performance.

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PLANNING & DESIGNING FOR HARMONIC SUPPRESSION

- Analyzing the spectra and knowing the size of systems planned, different solutions can be deduced and incorporated in the design that will lessen the disturbances or possibly eliminate them entirely.

Providing solution to Power Quality problems, cost

plays a major role. Hence it is always necessary to find cost effective solution to resolve Power Quality issues to minimize equipment downtime and loss of production by using Handy and Easy to use Instruments for Monitoring, Measuring and Recording all necessary values in three phase like TRU-RMS value, Voltage, Current, Frequency, Apparent & Reactive Power, Energy, Power Factor, Phase Angle and above all Harmonic Analysis with Transients events.

MECO POWER & HARMONIC ANALYZER

Meco Power & Harmonic Analyzer, AAnalyzer which is a state of the art versatile instrument using micro controller technology that would be ideal for an Engineer / Inspector for carrying out Periodic Visits, Vigilance checks, Surveys, Raids, Audits and Recording at Industrial and Consumers end.

- Graphic 3P4W System Parameters & Phasor Diagram
- Display of Overlapped Voltage & Current Waveform
- Display of 35 Parameters in One Screen
- Detection of Maximum 28 Transients with
- Programmable Threshold
- Display of 50 Harmonics IN One Screen with Waveform
- Display of Waveform with Peak Values
- Graphic Phasor Diagram with 3 Phase System Parameters
- Display of Overlapped Voltage and Current Waveform
- Programmable CT (1 to 600) and PT (1 to 3000) Ratios
- Active Power(W, KW, MW, GW), Apparent & Reactive Power (KVA, KVAR)
- Power Factor (PF), Phase Angle (Φ) & Energy (WH, KWH, KVARH, PFH)
- Average Demand (AD in W, KW, MW) & Maximum Demand (MD in W, KW, MW) with Programmable Period
- 512K Memory with Programmable Interval (1 to 6000 seconds, 17000 records for 3P4W System)
- Output of Waveform, Power Parameters and Harmonics at Command
- Large Dot Matrix LCD Display with Backlight

OBJECTIVE

Objective of is to provide steady state Harmonic Limits that are reasonable to both Electric Utilities & the Users.

- The power provider should limit Harmonic voltage since they have control over the system impedance
- The users should limit Harmonic Currents, since they have control over loads.
- Both parties share the Responsibilities for holding Harmonic levels in check.

Note: Some of the writ-up, example or case study taken from various articles in various General/Magazine for the awareness and knowledge of the Public issued herewith without any prejudice. E. & O.E.

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